Infiltration Basin

Mary Anne Lowndes
DNR

Post-Construction Stormwater Management Workshops
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WISCONSIN
DEPT. OF NATURAL RESOURCES

Infiltration Basins

Performance Standards

Infiltration Standard (by design)

- Residential
  - Infiltrate **90%** of the average annual predevelopment infiltration volume or
  - **25%** of the 2-year, 24-hour storm
- Non-residential
  - Infiltrate **60%** of the average annual predevelopment infiltration volume or
  - **10%** of the 2-year, 24-hour storm

Performance Standards

- Maximum effective infiltration area required to meet volume requirement
  - Residential: 1% cap
  - Non-residential: 2% cap
- Pretreat parking lots & roads

Performance Standards

Infiltration Standard Exclusions (Prohibitions)

- Certain industrial areas, contaminated soils & soil conditions
- Fueling & vehicle maintenance areas
- Within 3 or 5 feet to groundwater or bedrock
- Areas that lack proper soil texture (fines)
- Near karst features
- Near municipal or private wells

Performance Standards

Infiltration Standard Exemptions
(Not Required)

- Infiltration rate less than 0.6 inch/hour
- Highways & arterial roads
- Commercial, industrial & institutional roads
- Smaller parking lots & access roads
  - less than 5,000 feet^2
- In-fill areas < 5 acres & redevelopment areas
- During frozen soil conditions

Infiltration

- Intent is to return portion of pre-development infiltration volume
- Varies by residential or non-residential
- Not required where:
  - Groundwater contamination risk is too high
  - Land use carries a high pollutant load
  - Site is for redevelopment or < 5 acre in-fill
  - Infiltration is impractical

Infiltration Basin Definition

- Open Impoundment
- Greater than 15 feet wide at minimum
- Excavation or Embankment
- Flat, densely vegetated floor
- Dedicated to infiltration

Effective Infiltration Area

- Doesn’t include berms, site access, pre-treatment
- Doesn’t include ditches for conveyance
- Must be specifically designed to infiltrate

Benefits

- Reduces runoff volume and peaks
- Reduces pollutant loadings
- Reduces thermal impacts to stream
- Groundwater recharge
- Preserves base flow in streams

Pretreatment Requirement

- 60% reduction in TSS for Residential
- 80% reduction in TSS for commercial, industrial, institutional (and assoc. roads)

- Reason:
  - Long-term operation
  - Centralized device (failure is serious)


Cedar Hills
Pretreatment wet pond

Getting Started

- Use Site Evaluation Technical Standard to select a location on the site.
- Use infiltration rates identified in standard for soils at the site.
- Calculate required infiltration volume.
  - Use Tech. Note or approved model
  - http://dnr.wi.gov/org/water/wm/nps/stormwater/techstds.htm#Post

Technical Note

Technical Note for Sizing
Infiltration Basins and Bioretention Devices
To Meet Stormwater Infiltration Performance Standards

Table of Contents

Table 1. Directory of digital files referenced in this technical note.

File Content	Applicability	File Name
Technical note text	Infiltration Basins, Bioretention Devices	Technical Note for Sizing Infiltration Devices.doc
Target Stay-on Depth	Infiltration Basins, Bioretention Devices	Target stay-on requirements.xls
Silt loam soils, 3” pond depth	Infiltration Basins	Chart1madsiltloam3.xls
Loam soils, 6” pond depth	Infiltration Basins	Chart2madloam6.xls
Sand loam soils, 6” pond depth	Infiltration Basins	Chart3madsandyloam6.xls
Sand loam soils, 12” pond depth	Infiltration Basins	Chart4madsandyloam12.xls
Loamy sand soil, 6” pond depth	Infiltration Basins	Chart5madloamysand6.xls
Loamy sand soil, 12” pond depth	Infiltration Basins	Chart6madloamysand12.xls
Loamy sand soil, 18” pond depth	Infiltration Basins	Chart7madloamysand18.xls
Loamy sand soil, 24” pond depth	Infiltration Basins	Chart8madloamysand24.xls
Sand, 6” pond depth	Infiltration Basins	Chart9madsand6.xls
Sand, 12” pond depth	Infiltration Basins	Chart10madsand12.xls
Sand, 18” pond depth	Infiltration Basins	Chart11madsand18.xls
Sand, 24” pond depth	Infiltration Basins	Chart12madsand24.xls
RECARGA v. 2.3	Infiltration Basins, Bioretention Devices	RECARGA_2_3.exe (In Recarga Folder)
RECARGA User’s Manual v. 2.3	Infiltration Basins, Bioretention Devices	RECARGA2-3User_Manual.pdf

Effective Infiltration Area

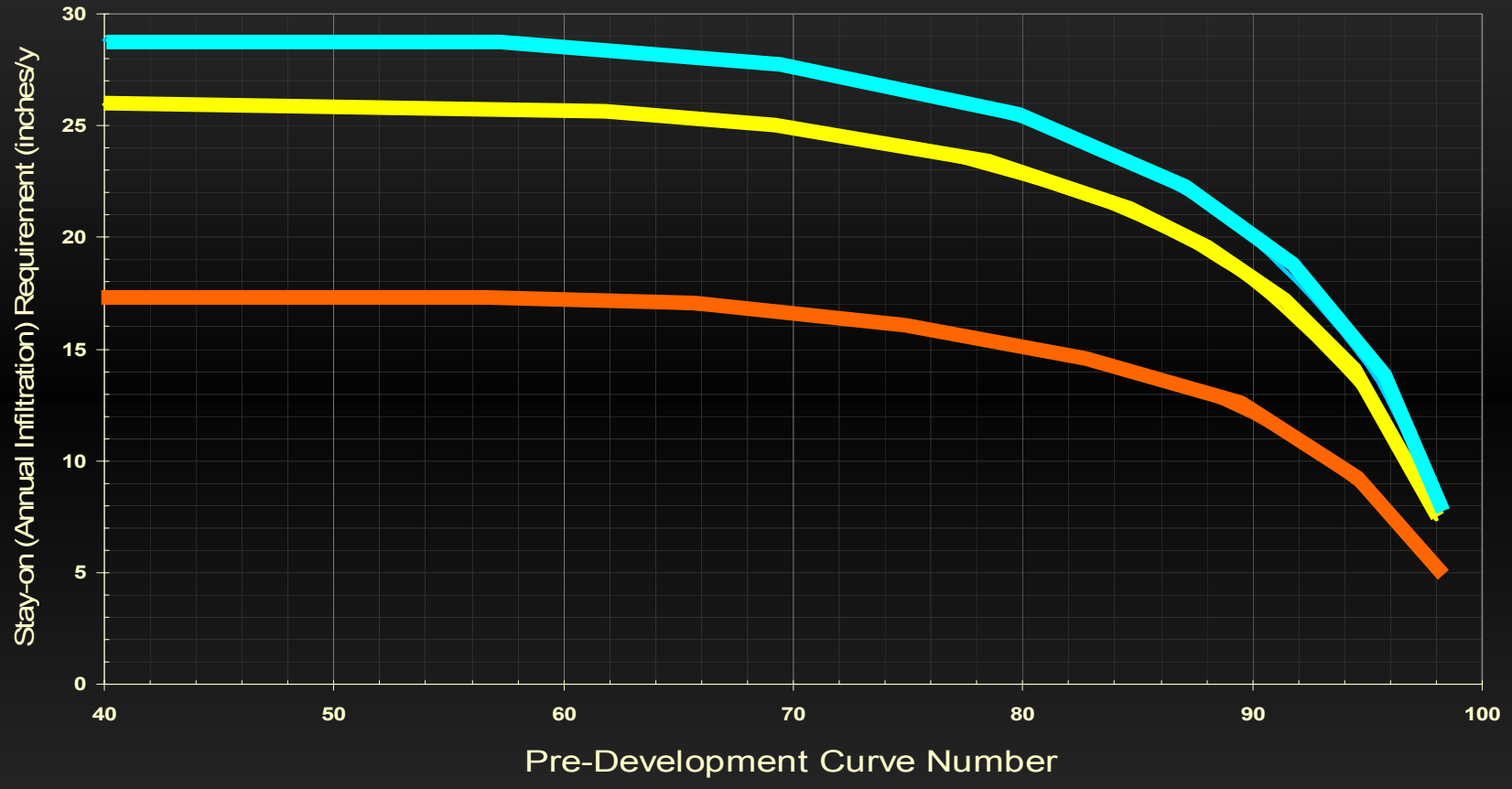
- Inputs:
  - Design infiltration rate of soil
  - Design ponding depth of basin
  - % total imperviousness of drainage basin
  - Curve number of pervious area in drainage basin
- Output is effective infiltration area to meet the performance standard.

Example

- 50 acres of cropland in loamy sand (Type A hydrologic group)
- Convert to 50 acres of medium density residential development (1/4 acre sites)
- From NR 151:
  - CN for cropland is 56

CHART 1 - TARGET STAY-ON (ANNUAL INFILTRATION) REQUIREMENT

Based on the annual 1981 Rainfall for Madison, WI



Note: 100% Predevelopment represents infiltration under predevelopment conditions

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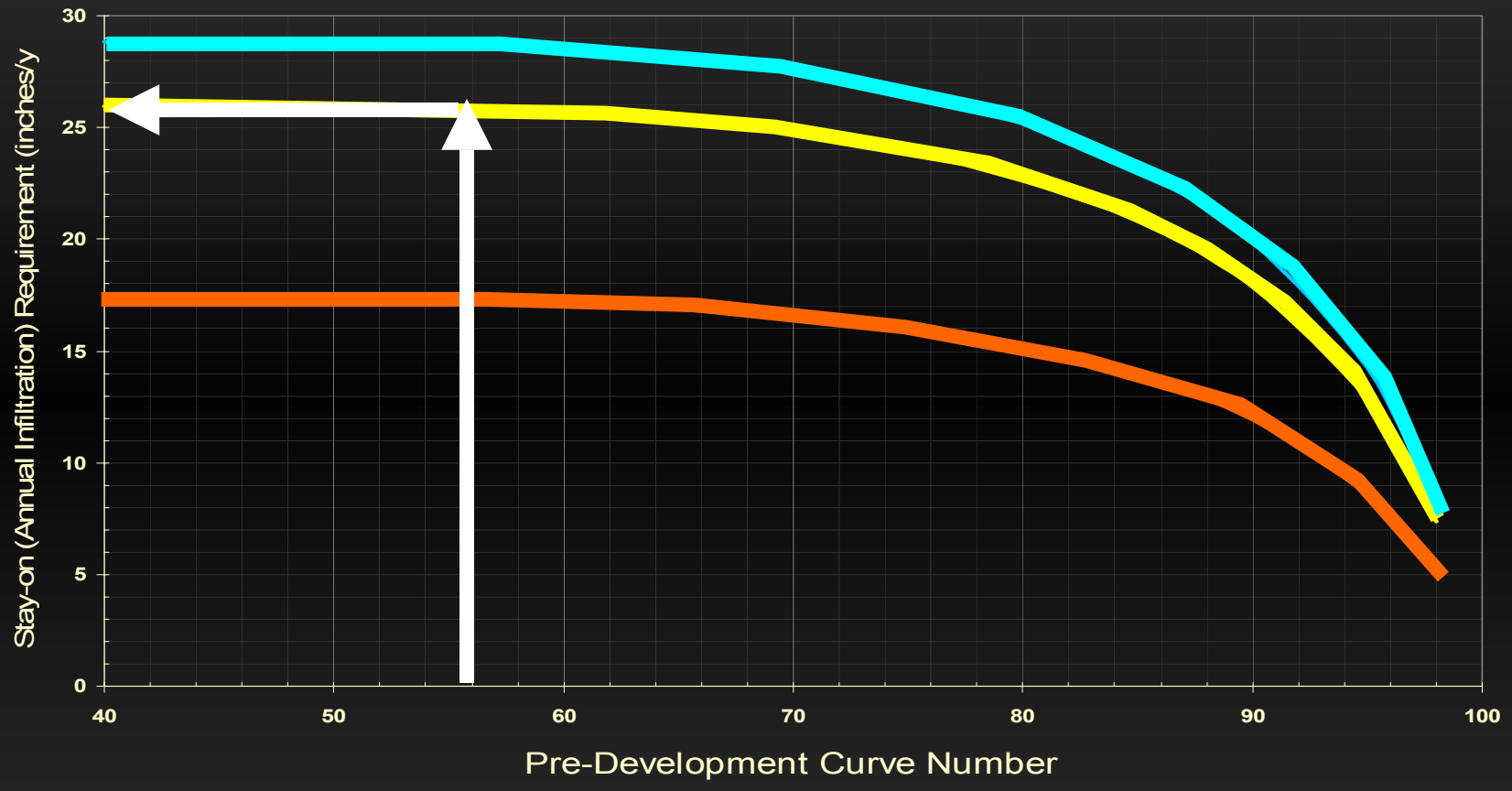


Note: 100% Predevelopment represents infiltration under predevelopment conditions

Table 3. Combinations of infiltration rates and ponding depths covered by Charts 1-12 listed in Table 1.

Soil Texture	Design Infiltration Rate (Kd), inches/hour	Basin Design Ponding Depth, inches
Silt loam	.13	3
Loam	.24	6
Sandy loam	.5	6
Sandy loam	.5	12
Loamy sand	1.63	6
Loamy sand	1.63	12
Loamy sand	1.63	18
Loamy sand	1.63	24
Sand	3.6	6
Sand	3.6	12
Sand	3.6	18
Sand	3.6	24

Example continued

- Target stay-on-depth = 26 inches
- Medium density residential:
  - 40% total imperviousness
  - Pervious area CN of 60
- Choose to maximize depth
  - Use nomograph (Chart 8) for loamy sand, infiltration rate of 1.63 in/hr, 24 inch depth

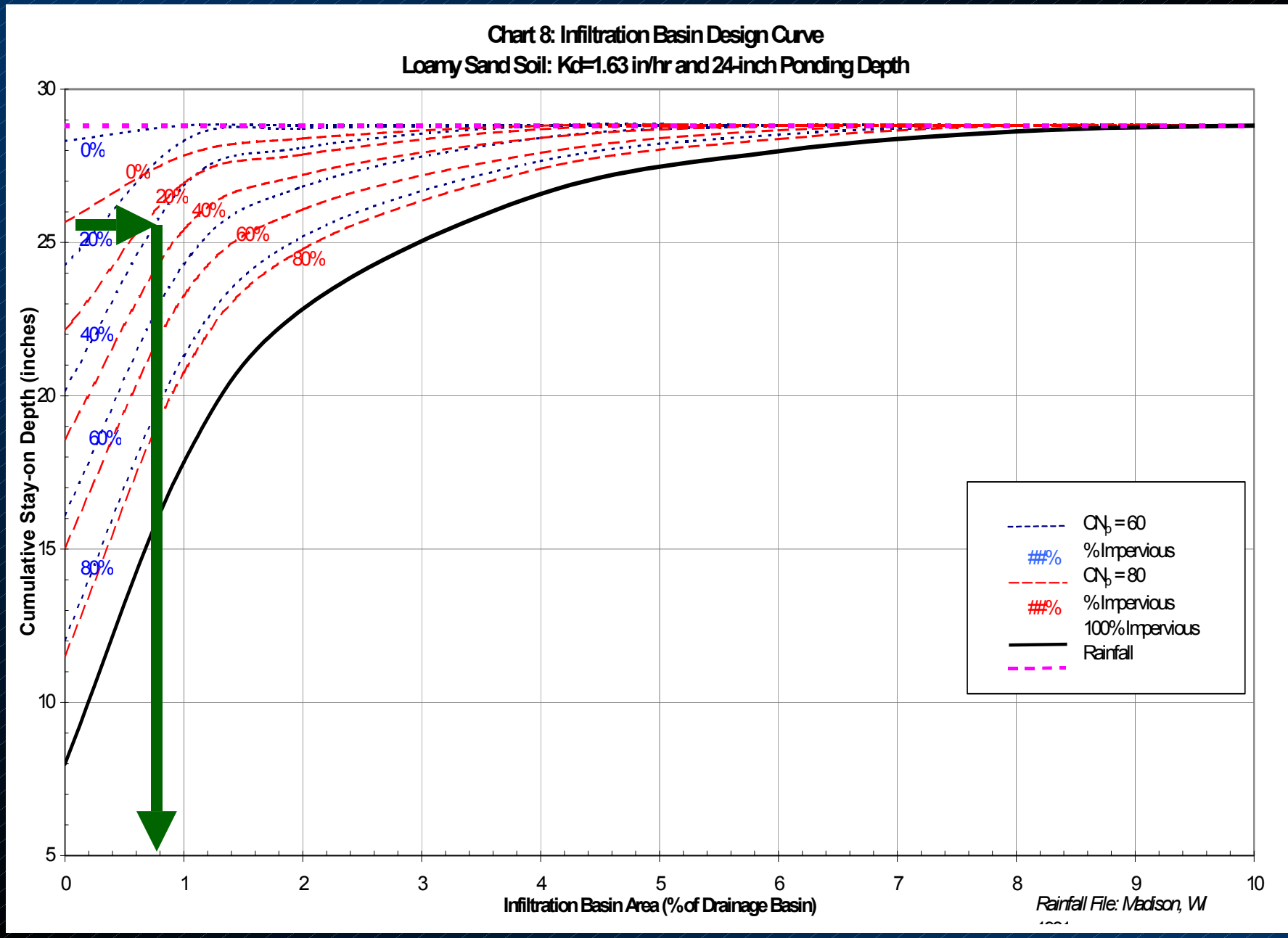


Chart 8: Infiltration Basin Design Curve
Loamy Sand Soil: Kcl=1.63 in/hr and 24-inch Ponding Depth
Cumulative Stay-on Depth (inches)
Infiltration Basin Area (% of Drainage Basin)
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
0%
0%
20%
40%
60%
80%
20%
40%
60%
80%
CNb = 60
##% Impervious
CNb = 80
##% Impervious
100% Impervious
Rainfall
Rainfall File: Madison, WI

Dimensions

- Depth
  - Not to exceed 24 inches
  - maximum draw down within 24 hours (necessary to preserve vegetation)
  - Applies to all cells (need cells when flow path exceeds 300 ft.)
- Area
  - Calculate infiltration volume based on target stay-on-depth, infiltration rate

Dimensions continued

- Slope
  - Longitudinal slope not to exceed 1% (prefer a flat bottom)
    - Correction needed for longitudinal slope if present
  - Lateral slope shall be 0%
  - Side slopes (interior and exterior) at 4:1 or flatter

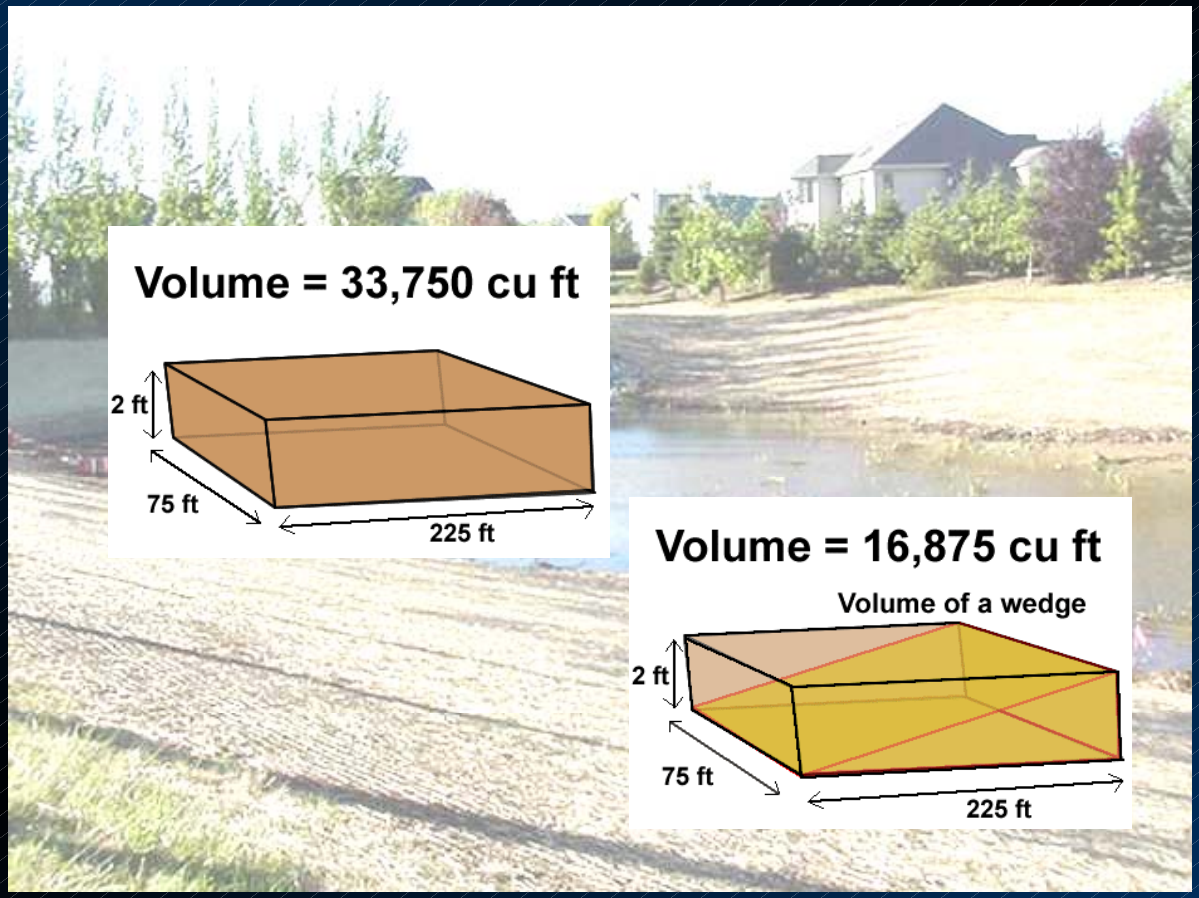
Example continued

- From Chart 8
  - Surface area equal to 0.75% of drainage area
- Calculate Dimension
  - 50 acre drainage area
  - Required area - 0.375 acres = 16,500 sq. ft.
  - Volume at 2 ft depth = 33,000 cu. ft.
  - Assume 3:1 length to width ratio dimensions will be approximately 75ft. X 225 ft.

Example continued

- For a flat bottom basin
  - 2 ft. X 75 ft. X 225 ft. provides the required infiltration volume and no cell breaks needed (2 foot depth is maximum from standard)
- For a basin with a 1% longitudinal slope
  - Area needs to be twice above area to account for triangular area lost
  - Cannot exceed 2 ft. of depth
  - Now cells will be needed

Longitudinal Slope Adjustments



Cells and Level Spreaders

- Sheet flow maximizes area for infiltration
- Channelized flow may occur by 300 feet
- Divide area into cells
- Utilize level spreaders at inlets to basin and cells
- Each cell cannot exceed 24 inches in depth
  - Further depth restriction by soil type for 24 hour maximum draw down.

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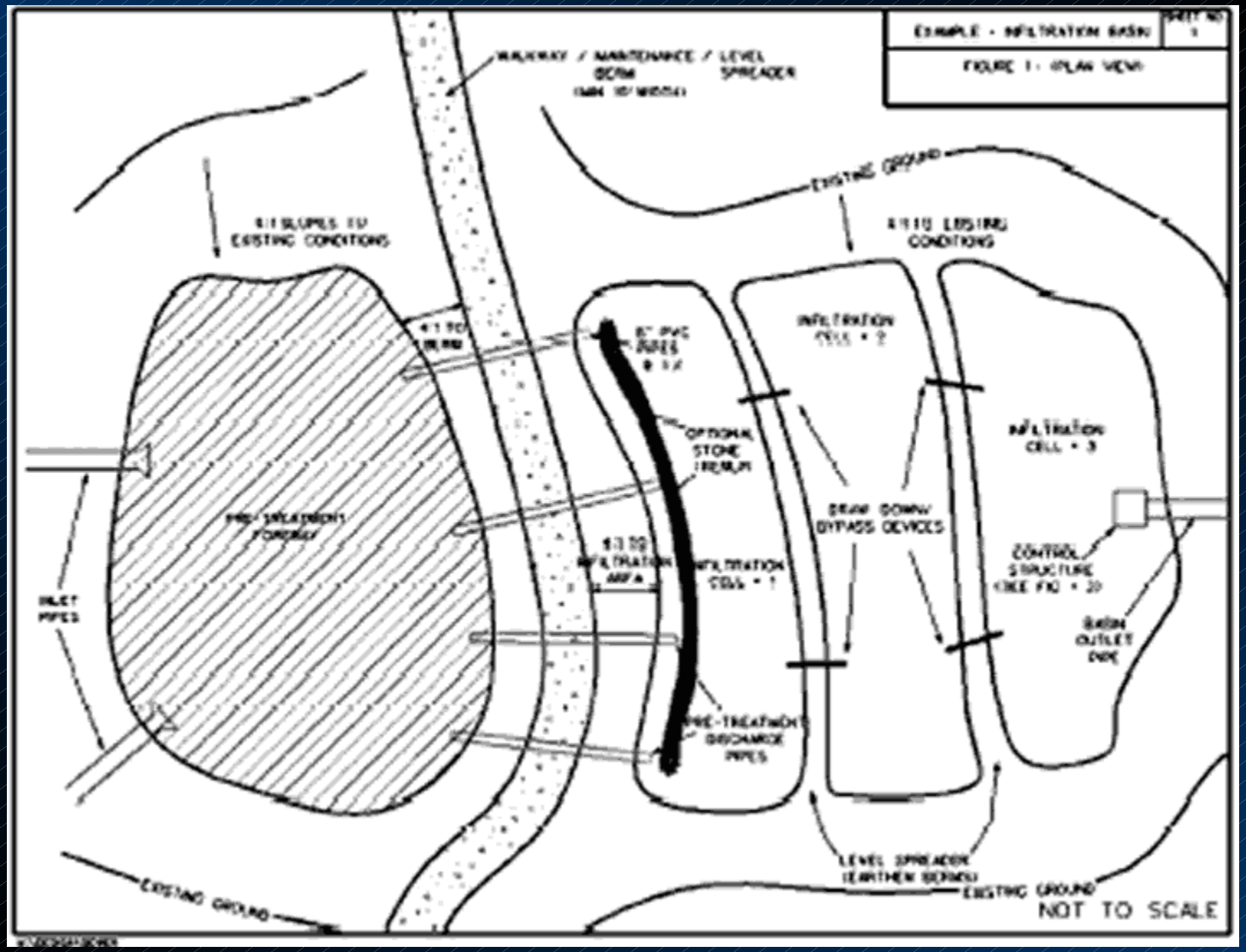
Cedar Hills Infiltration Basin under Construction
Inlets and Stone Trench Level Spreader


EXAMPLE - INFILTRATION BASIN
FIGURE 1 - (PLAN VIEW)
WALKWAY / MAINTENANCE / LEVEL SPREADER BERM
EXISTING GROUND
EXISTING CONDITIONS
INFILTRATION CELL # 2
INFILTRATION CELL # 3
OPTIONAL STONE TRENCH
DRAW DOWN BYPASS DEVICES
CONTROL STRUCTURE
BASIN OUTLET PIPE
INFILTRATION CELL # 1
INLET PIPES
LEVEL SPREADER (EARTHEN BERM)
EXISTING GROUND
NOT TO SCALE

Final Area

- Calculate from table for soils and max. ponding depth. - preliminary effective infiltration area
- Increase effective infiltration area for longitudinal slope
- Add area for berms and cells

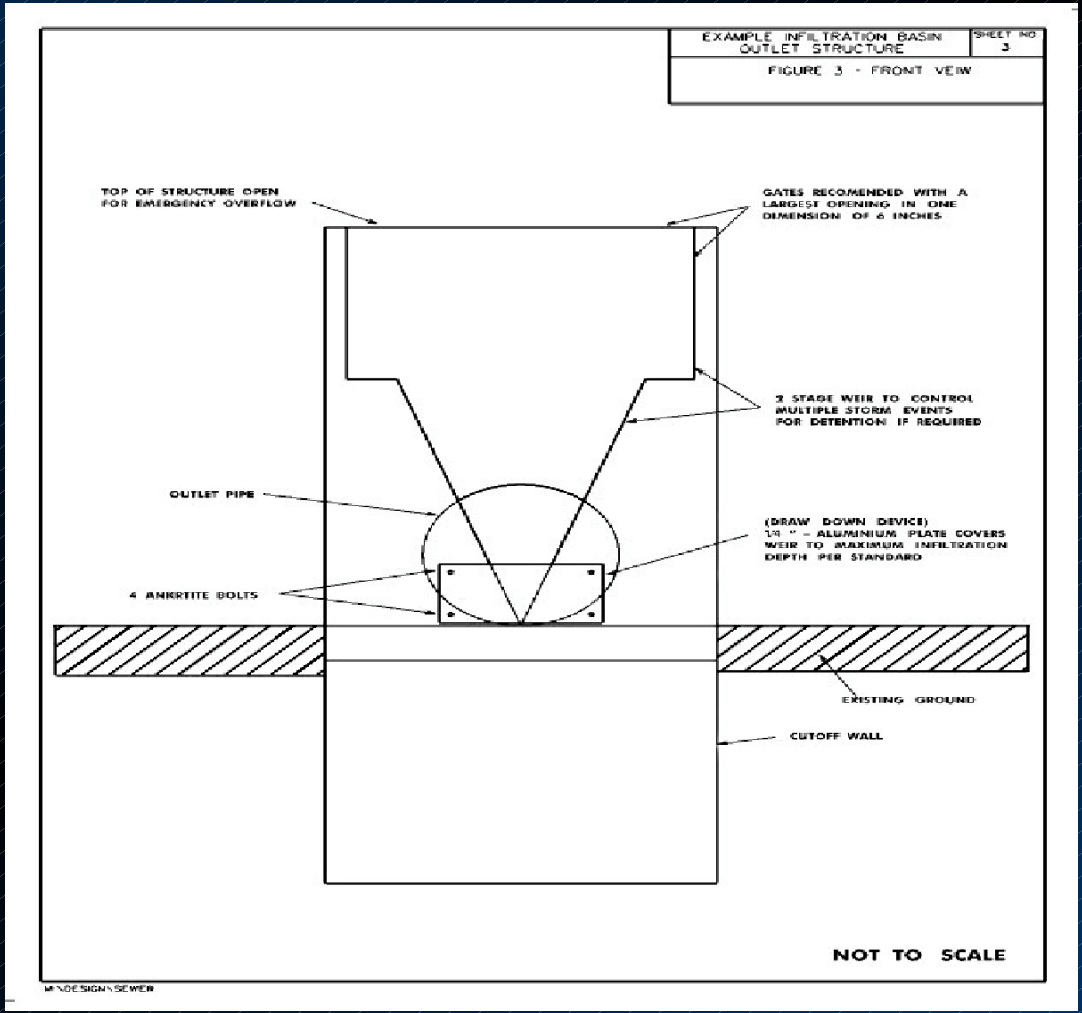

Infiltration basin with no cells

Outlets

1. Draw down device
2. Emergency spillway
   - Designed for 100 year - 24 hour event
   - One foot of freeboard required
3. Peak flow control - optional


Multiple Purpose Basin

Outlet Option



Draw-Down Device

- Maintenance feature
- Draw down needed for each cell
- Used to bypass during winter if salt is an issue

Construction Criteria

Compaction and Vegetation

Construction Phase

A. No Disturbance

B. Compaction Mitigation

- Incorporate soil additives
- Chisel plow or rotary device to 12 inches
- Add acceptable compost

- Don’t build during rain events because of smearing potential


Compaction from Heavy Equipment


Deep-Tilling


Ridge and furrow effect
Can fill quickly with sediment
Suggest chisel plow or rotary device

After Construction

- Survey basin to verify elevations and grades
- Keep basin off-line until
  - 90% build-out is achieved (first 3 years)
  - 75% build-out (years 4 to 5)
  - 5 years from construction

Vegetative Cover

- Turf Grass
  - During establishment use a cover crop with permanent seeding
  - No sod
- Native Vegetation
  - Use recommendations of qualified nursery with experience in native vegetation
  - Seed in fall or spring or use plugs
- Use fertilizer and mulch appropriately


Cedar Hills
Infiltration Basin

Considerations

- Multiple uses
  - Infiltration and peak flow shaving
  - Flow splitter
- Drainage area
  - 5-50 acres
  - Use multiple basins for > 50 acres
- Level spreaders
  - Difficult to achieve
  - Berm / stone trench or ridge and furrow

More Considerations

- Have the landscape contractor do final grading.
- Don’t use infiltration basin for snow storage.
- Infiltration basins in internally drained watersheds may need to exceed depths, may need different kinds of plants, may need more frequent maintenance

Operation and Maintenance

- Inspect spreader, outlets and vegetation quarterly
- Native vegetation can be mowed or burned
  - Procedures provided in standard
- If standing water is observed over 50% of effective infiltration area three days after rainfall - IT'S CLOGGED

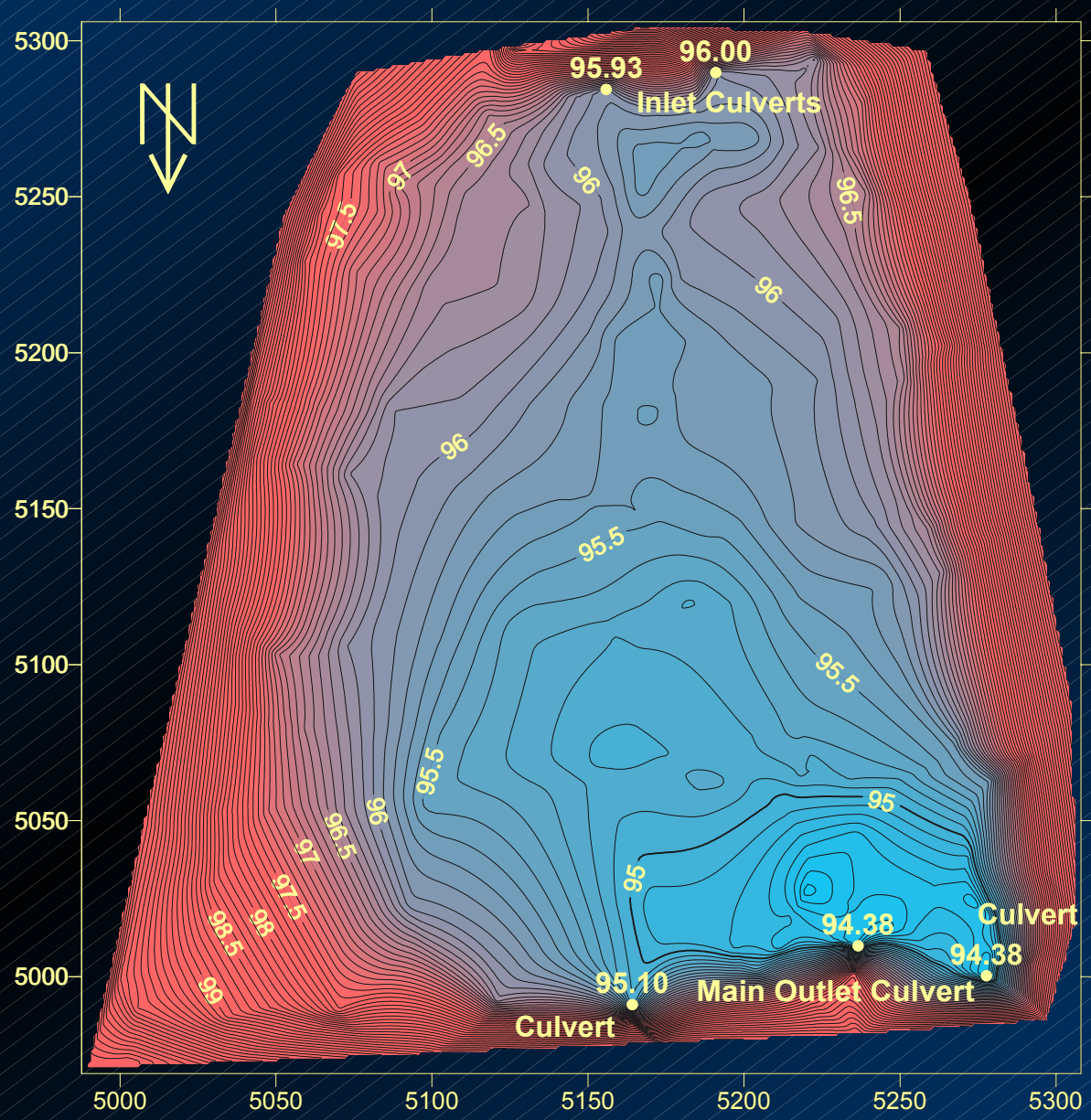
Restoration

- Drain basin
- Remove top 2-3 inches
- Chisel plow or deep till
- Add topsoil and compost
- If this fails to correct the problem and the basin is planted in turf grass - replant with deeper rooted vegetation

Level Bottom

- Difficulty in maintaining a flat or level bottom
- Short-circuiting affects effective infiltration area
- Can lead to early failure or more frequent overflow.

Detention Pond Elevations at Hwy KP
Surveyed 5/25/00
0.1' Contour Intervals



Short-circuiting

- Infiltration basin was constructed with a drainage pattern down the middle
- Previous slide mapped the problem
- Contract to redo basin floor to provide a flatter bottom
- After second attempt, basin still only uses portion of the available infiltration area
- Cells would be an option

Effective Infiltration Area Compromised

Winter Maintenance

- Use drawn down device to take infiltration basin off-line during winter conditions if:
  - Drainage basin uses chlorides for de-icing in significant amounts
- If basin is enclosed or diversion is not possible - limit use of chloride deicers in the drainage basin.

Visual Clues to TSS Concentration Variation

Blue = KP

Red = Bourbon